Common CBM beam test of the RICH, TRD and TOF subsystems at the CERN PS T9 beam line in 2012 *

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A common beam test of the CBM Ring Imaging CHerenkov (RICH), Transition Radiation Detector (TRD) and Time Of Flight (TOF) subsystems was performed at the CERN Proton Synchrotron (PS) accelerator in October/November 2012. The measurements were carried out at the T9 beam line in a mixed beam of electrons and pions with momenta from 2 to 10 GeV/c. In addition to the above mentioned detectors, the setup consisted of: two Cherenkov detectors, two fiber-trackers, beam trigger scintillators and a lead-glass calorimeter. The first fiber-tracker was placed at the upstream end of the setup, followed by a large volume RICH prototype, 8 real-size TRD prototypes, 2 TOF detectors and finally the second fiber-tracker at the downstream end, see Figure 1.

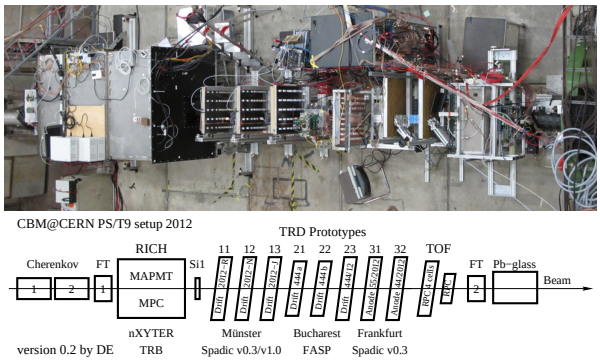

Figure 1: Setup of CBM in the PS/T9 beam line in 2012.

The RICH prototype [1] was based on a mirror focusing setup with CO_2 gas as radiator. The photon camera was composed of 4 micro channel plate (MCP) detectors plus 20 Hamamatsu multi-anode photo-multipliers (MAPMTs). Two concurrent approaches to readout the RICH camera were tested: the traditional trigger-less nXYTER front-end as well as a free streaming approach based on the HADES Trigger and Readout Board (TRB3).

The TRD laboratories in Münster [2], Bucharest [3],[4] and Frankfurt [6],[7] have built real-size (59×59 cm^2) detector modules based on MWPC technology with cathode pad readout. The large size of the TRDs has triggered innovative developments to stabilize the entrance window to the gas volume, while minimizing the loss of transition radiation between the radiator and the detection volume.

* Work supported by BMBF, EU-FP7/HP3 Grant No. 283286 and NASR/CAPACITATI contract no.179

The readout of the Bucharest prototypes was based on the Fast Analog Signal Processor (FASP) ASIC, either digitized in a VME-based MADC32, or using free streaming MAXIM [5] based converters. The signal processing on the TRD modules from Münster and Frankfurt was performed with the SPADIC v0.3 from 2011. A TRD prototype from Münster served as platform to compare the performance of the FASP, the SPADIC v0.3 and the recently developed SPADIC v1.0 [8],[9]. The latter reads out 32 channels in self-triggered mode and implements the CBMnet protocol on the ASIC. The TRD test program consisted of a systematic study of different radiator prototypes with a Xe(80%)+CO_2(20%) gas mixture in the detection volume, as well as beam momentum and high voltage scans.

Bucharest completed the setup with a segmented TOF prototype, consisting of 4 partially overlapping RPC cells, combined with a single RPC cell reference TOF prototype from 2011. These 2 TOF modules were again tested using a $C_2F_4H_2$(90%)+SF_6(5%)+iso-C_4H_{10}(5%) gas mixture allowing for fast signal generation.

All prototypes under test were read out in a common hybrid data acquisition system based on MBS and DABC.

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